



IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: Seifalian *et al*

Serial No.: 10/586,649

Filed: January 20, 2005

For: POLYMER FOR USE IN CONDUITS, MEDICAL DEVICES AND BIOMEDICAL  
SURFACE MODIFICATION

DECLARATION

I, Arnold Darbyshire, do hereby declare and state as follows:

1. I am one of the inventors for US patent application no. 10/586,649 and have a thorough knowledge of the invention.

2. I have been asked to consider whether the POSS-containing copolymers described in US 2005/0010275 A1 of Sahatjian *et al* have the same properties as the copolymers defined in the amended version of claim 38 of US patent application no. 10/586,649, with which this declaration is being filed. That amended claim 38 is limited to require the ratio of silsesquioxane-containing segments : polyol segments to be 1 : X wherein X is 10 or more.

3. I believe that there are significant differences between the copolymers described by Sahatjian *et al* and the copolymers of claim 38 of US patent application no. 10/586,649. For instance, the respective copolymers have different physical properties at the temperature at which they are intended to be used, namely body temperature. This is explained in more detail below.

4. Sahatjian *et al* are concerned with copolymers for use in stents. Their aim is to produce a stent that can be inserted into the human body and then heated in order to soften it. Once softened, the stent is then expanded to the lumen wall in the desired location, e.g. by a balloon. Having the stent in a softened state means that the expansion is predicatable and reliable, kinks can be avoided, and proper apposition against the lumen wall can be achieved (see e.g. [0068]). After cooling back down to body temperature in the desired location, the stent regains its hardness and is left in place to support the lumen wall. It is important that when the stent is in the softened form, it does not lose shape.

5. Sahatjian *et al* teach that the way to do this is to use a copolymer with a glass transition temperature that is above body temperature, but not too much higher than it. In particular, the glass transition temperature should be in the region of 40-50 °C. That is high enough above

body temperature to ensure the stent is not too soft before and after cooling, but is not so high that the necessary heating is unsafe (see e.g. [0072]).

6. I have been asked to consider the POSS-containing copolymers of Sahatjian *et al.* Paragraph [0131] of Sahatjian *et al* indicates that the envisaged POSS-containing copolymers contain X POSS units and Y polyol units, wherein X/Y is 1 to 20. Figure 8A of Sahatjian *et al*, reproduced below, depicts DSC scans for four such copolymers, namely PEG+POSS copolymers with PEG:POSS molar ratios of (A) 1:3, (B) 1:4, (C) 1:6 and (D) 1:8.

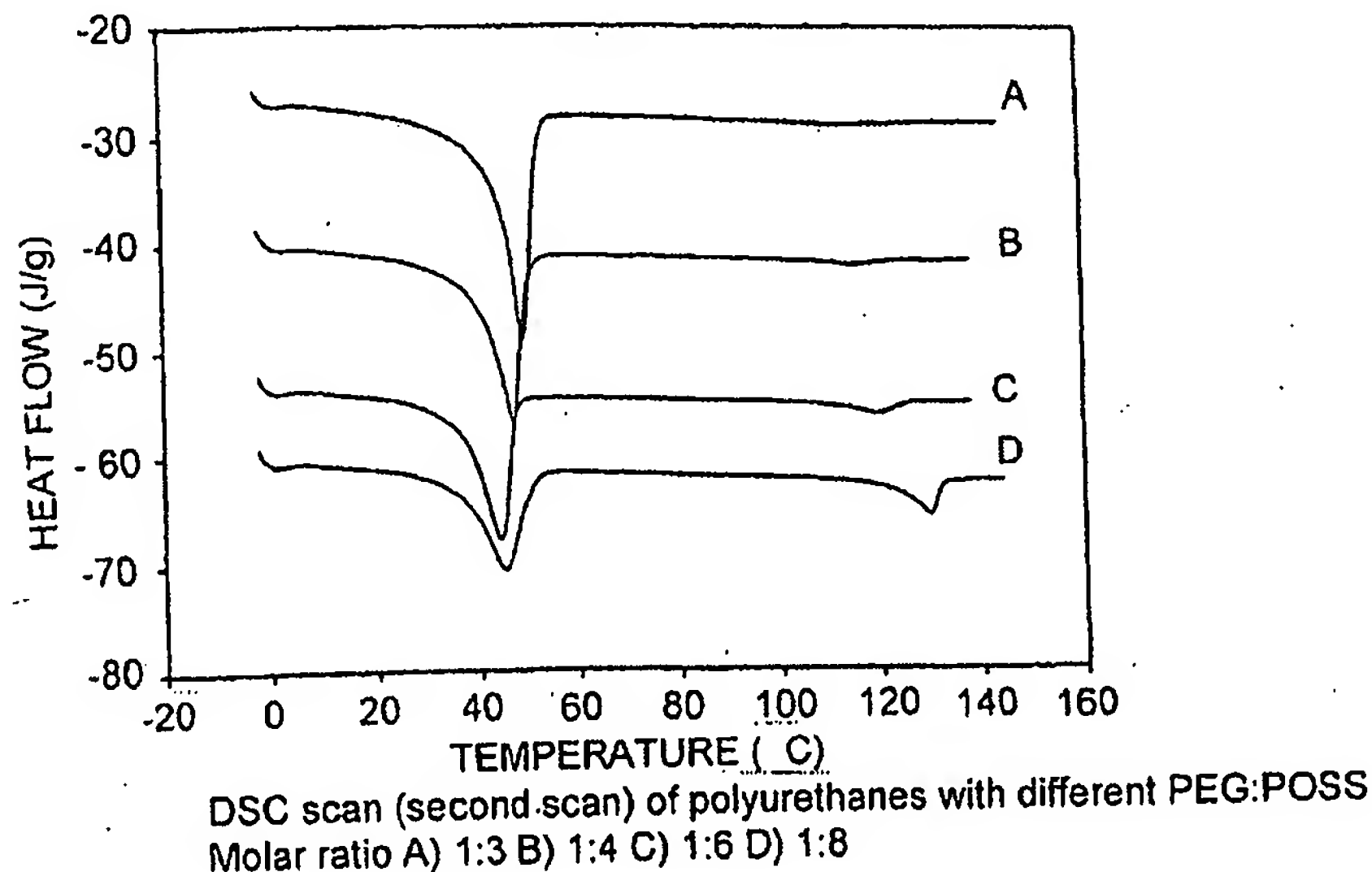


FIG. 8A

7. The sharp troughs in the plots on Figure 8A in the 40-50 °C region indicate the glass transition point. Thus, all of the POSS-containing copolymers described in Sahatjian *et al* have a glass transition temperature in the desired 40-50 °C window.

8. The copolymers of amended claim 38 of US patent application no. 10/586,649 differ from those of Sahatjian *et al* in that they contain a much smaller proportion of POSS, the maximum amount of POSS being expressed as a POSS : polyol ratio of 1:10. This reduced amount of POSS leads to copolymers with markedly different glass transition temperatures. To establish this we have produced copolymers composed of POSS and polycarbonate urea-urethane (PCU) and conducted DSC scans in Nitrogen (10 °C/min) (see Annex). The copolymer with a POSS : polyol ratio of 1 : 10 had a glass transition temperature (T<sub>g</sub>) of -30.83 °C. The copolymer with a ratio of 1 : 17 had a T<sub>g</sub> of -30.47 °C.

9. These results clearly indicate that copolymers of claim 38 of US patent application no. 10/586,649, which have at least 10 times more polyol segments than POSS segments, have significantly lower glass transition temperatures than the POSS-containing Sahatjian *et al* copolymers (values of about -30 °C compared to values of about +45 °C). I believe that is because the copolymers of Sahatjian *et al* have so many more bulky POSS groups on

copolymer side chains, which have an anchoring effect. The upshot is that at body temperature the copolymers of Sahatjian *et al* are significantly harder and less flexible.

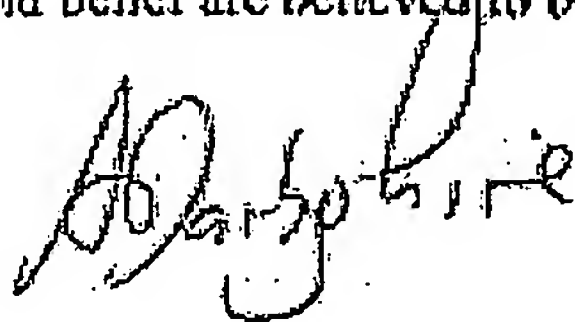
10. The different physical properties of the two types of copolymer are entirely consistent with the different intended uses. Thus, as explained in the opening four paragraphs of the background section of US patent application no. 10/586,649, that application relates to prosthetic vascular grafts, e.g. for use in bypass grafting with autologous veins or arteries. Suitable materials for this should have properties that match as closely as possible the properties of the blood vessel that the graft is intended to mimic. Thus, to avoid a compliance mismatch the copolymers have a very low glass transition temperature, to ensure that the material is flexible and elastic at body temperature.

11. The POSS-containing copolymers of Sahatjian *et al*, on the other hand, need to have a glass transition temperature above body temperature because they must be strong once they have cooled back down (after being heated and expanded and then left in the body to keep open the relevant passage). Otherwise, they would not be able to support the urethra and keep it open in the face of pressure from an enlarged prostate (see the background section on page 1 of Sahatjian *et al*).

12. I have also been asked to comment on whether the differences between the invention as claimed in claim 38 of US patent application no. 10/586,649 and the teaching of Sahatjian *et al* are such that the subject matter claimed in US patent application no. 10/586,649 would have been obvious to person of ordinary skill in the art, prior to the filing date of US patent application no. 10/586,649. The POSS-containing copolymer of Sahatjian *et al* contains 1 to 20 times as many POSS units as polyol units. Said claim 38, on the other hand, requires at least 10 times as many polyol units as POSS units. I believe that no skilled person would have even contemplated making such a drastic change to the POSS:polyol ratio in Sahatjian *et al*, because they would know that it would prejudice the glass transition temperature, by lowering it to well below body temperature. That would defeat the whole object of the copolymer stents described in Sahatjian *et al*.

13. I acknowledge that wilful false statements and the like are punishable by fine or imprisonment, or both, and may jeopardize the validity of the application or any patent issuing thereon. All statements made of my own knowledge are true and all statements made on information and belief are believed to be true.

Signed



## ANNEX

## Heating DSC scans in nitrogen (10 °C/min) for P9 with different POSS levels

Copolymer	Molar ratio polyol:POSS	
<sup>1</sup> (A) Polycarbonate urea-urethane (PCU)	-	
<sup>1</sup> (B) 2% POSS-PCU	1 : 0.06	(~ 17 : 1)
<sup>1</sup> (C) 4% POSS-PCU	1 : 0.1	(~ 10 : 1)
<sup>1</sup> (D) 8% POSS-PCU	1 : 0.25	(~ 4 : 1)
(E) 28% POSS-PCU	1 : 1	

Sample	T <sub>g</sub> (°C)	T <sub>m</sub> (°C)	C <sub>p</sub> (J/gK)
(A) PCU	-29.80	279.75	0.0121
(B) POSS-PCU2	-30.47	281.19	0.0144
(C) POSS-PCU4	-30.83	286.55	0.0203
(D) POSS-PCU8	-31.79	291.78	0.0285
(E) POSS-PCU	-20.0	160.0	

## Reference List

1. Bakhshi R. Coating stent materials with polyhedral oligomeric silsesquioxane-poly(carbonate-urea)urethane nanocomposites. PhD Thesis, University College London, 2009. Supervisors, Professors Seifalian & Edirisinghe